Course: PHYS 800
Term: Perennial

INSTRUCTOR CONTACT INFORMATION

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COURSE OBJECTIVES AND LEARNING OUTCOMES

Graduate Research PHYS 800 is the centerpiece of the graduate experience in the Department of Physics and Astronomy at Rice. Those students who affiliate with Prof. Baring enjoy the opportunity for theoretical work in one or more areas of his specialization in astrophysics and cosmic ray physics. These include magnetars, pulsars, supernova remnants, relativistic jets in active galactic nuclei, gamma-ray bursts, cosmic ray generation and propagation, plasma shock acceleration theory, QED radiation processes, plasma physics mechanisms, and hadronic interactions in tenuous gases. The material covered in research provides an excellent forum for those interested in employing their knowledge of particular advanced subfields of physics, such as quantum mechanics, Einstein's theories of special and general relativity, plasma physics, particle physics and occasionally condensed matter physics. Accordingly, most students who affiliate with Prof. Baring normally have strong backgrounds in physics coursework, enabling them to maximize the yield of their research experience. His students receive close supervision, a time investment that makes for a very strong training. Prof. Baring's PhD students place well upon graduation.

Objectives: The goal of PHYS 800 is to provide students with a basic understanding of the research process, specifically in the addressing theoretical astrophysics topics using physics and mathematics to guide model construction, and numerical methods to provide insights as needed. Students will learn that research is a dynamic phenomenon. Hypotheses define paths and more often than not, surprises ensue and both the paths and hypotheses are revised. The sequence continues in an ebb and flow pattern, with dead ends and breakthroughs interspersed. While this may be unsettling at first, as the student gains experience, he/she will learn to navigate such episodes with greater confidence and define longer term visions beyond the immediate tasks. Students will assimilate how to frame problems and tasks, moving from incipient phases of the PhD where the picture and the tasks are usually defined by Prof. Baring. Students will be taught to think logically and critically about what are reasonable assumptions in physical developments and what are not, and how to evaluate and check derived results. They will also be taught how to think "laterally" by connecting seemingly unrelated concepts to enhance understanding of a given problem or task. This will apply both to analysis methods and occasionally also in developing computational skills. In this way, a student will master the research process, to prepare them for their postdoctoral career, whatever form that takes. Most importantly, students will have fun doing research, showcasing their creative juices and intellectual aptitude.

Learning Outcomes: By undertaking graduate research with Prof. Baring, students will be in an excellent position to assess posed problems, suggest algorithms for approaching analytic and computational tasks, test their ideas, and develop efficient strategies for reducing a problem to a tractable form, or an endpoint that will facilitate numerical evaluation. They will receive training in communicating their ideas, hypotheses and understanding of select issues to an ensemble of their peers. This is the essence of the research process: think critically, probe, discover, revise one's perspective and tell the broader community of the results and the path taken to get there, and where to go next. This is invaluable training for an array of professions and potential careers down the line, including industry, business and academia.

COURSE SELECTION

The suite of courses a graduate student undertakes defines an essential preparation for research. Prior to research affiliation, the student should select courses that they feel might best suit their planned direction. After affiliation with Prof. Baring, you **will consult with me prior to each semester** to lay out a gameplan for classes to select for the upcoming semester. This will usually extend to future semesters to map out the plan based on course availability on the horizon. The consultation requirement is mandated because it maximizes the prospects for strong preparation for future research projects, and will aid identification of courses that match your interests. You will be expected to complete all required courses by the end of his/her fourth semester in preparation for the Defense/PhD Candidacy exam in the fifth semester of graduate students in the Physics and Astronomy Department. On a case-by-case basis, there may prove to be exceptions to these guidelines, for example if the student would like to undertake or audit a course after successful PhD candicacy, and/or Prof. Baring encourages such as part of the student's broader education. If **exceptional circumstances arise**, such as through illness or a significant family circumstance, the timeline for coursework completion and defense can be adjusted; *this would require close consultation with and the agreement of both Prof. Baring and the current Chair of the Graduate Studies Committee in the Department of Physics and Astronomy*.

GENERAL READING

Surveying the literature in the general field of research chosen by a student is imperative to superior professional development. In the course of the project, quite a number of papers will be read and their contents digested by a graduate student during the path to preparation of publications and eventually the PhD thesis. Prof. Baring desires his students to go beyond this in exploring papers not necessarily intimately connected with the details of the research, thereby developing a broader intellectual base for contributing to the astrophysics field. To this end, you should **aim to read and internalize the content of at least one paper per week** in addition to those you would normally read for your project. This will form a foundation that will both enhance your graduate study experience, but also prepare you for postdoctoral forays in your chosen path, whether that be a research fellowship or a job in industry, etc. This investment will also help you in discerning writing styles in preparation for crafting your papers and thesis.

SEMINAR ATTENDANCE

The astronomy/astrophysics sector of the Physics and Astronomy Department runs a seminar course ASTR 500 at lunchtimes on Wednesdays, the so-called Astronomy Unit (AU). Often there are external guests of astronomy/astrophysics faculty who are experts in their fields, who in delivering AU seminars and interacting with us during their visits, enrich the discourse on campus and provide a view for students into the broader research world beyond the hedges. Undergraduate and graduate students who take the course also are required to give a half-seminar on either their research or on a journal paper. Therefore, this seminar series provides excellent exposure to astronomy that expands a student's perspectives. It also affords the opportunity for students to hone their presentation skills, an important part of professional preparation. Graduate students who affiliate with Prof. Baring are **strongly encouraged to participate in the seminar series** and register for ASTR 500, each semester. They are also encouraged to attend the Wednesday afternoon Physics and Astronomy Colloquium series, to learn more about broader elements of physics research. These two series are invaluable opportunities for students to bolster their intellectual base and appetite for science.

CONFERENCE ATTENDANCE

It is customary for Prof. Baring's students to **attend one conference a year**, occasionally more, starting in their third year when their research resumé has grown sufficiently. This is an integral portion of a graduate student's professional development. This adventure exposes you to an array of cutting edge research that is topical and provides a survey of your field and beyond. Attending meetings provides perspectives on science, will fuel your excitement about your research and hopefully seed productive ideas and help identify directions your research program might take. It provides an opportunity for the student to showcase his/her research to peers and prospective future employers, and so serves an essential networking function. A peripheral benefit is that you get to travel to interesting places. Through the conference prism, you will quickly discern how truly international and diverse the astrophysics community is.

RESEARCH EFFORT POLICIES

The quality of the research product increases with the effort invested by the student. This means that after PhD candidacy, Prof. Baring expects the students to work full time on research. The definition of full time is somewhat subjective, but it usually means at least 40 hours per work week. The onus for effort is on the student, and will define the outcome of the PhD. The drive that a successful student possesses may extend this time investment considerably; such is natural for researchers when they are "all-in" on their projects. However, the productivity curve flattens if fatigue sets in, and Prof. Baring recommends that students generally limit their work ethic to around 50-55 hours per week in order to spend time on other aspects of their lives, including relaxation and extracurricular activities. Being refreshed improves mental efficiency and can provide new impetus for research tasks. This model extends to the annual cycle. Dr. Baring allows and expects his students to have vacation time, and generally this should be more than the typical US model of 2 weeks per year in the broader community. This is dealt with on a case-by-case basis, but should not exceed 4 weeks per year in total given that students are supported by federal grants. Vacation time dates should be discussed with Dr. Baring at least a month in advance of the intended absence to assist long term planning.

ABSENCE POLICIES

Infrequent short absences are not a problem. If there is a medical situation, or other personal matter that may impact research time significantly, you should communicate with Prof. Baring as a courtesy, and in a timely fashion (if possible) to determine the appropriate course of action in terms of research accommodations. This is to your benefit. Exceptional circumstances may require official leaves, and these need to be approved by Graduate Studies in advance of extended absences.

ANNUAL COMMITTEE MEETINGS

The Department of Physics and Astronomy introduced advisory committees for graduate students some years ago. These are formed in order to *mentor you and keep your progress on track*. You **meet nominally once a year with the committee members**, three in all, either together or individually, to apprise them of your course and research progress, and to discuss any pertinent issues that you or they feel need to be addressed. These are an important part of the graduate student experience in the Department, and provide both a useful resource and a safety net for you: the identification of potential problems in a timely fashion can prevent escalation of them that might arise if they were not attended to. The committees for Prof. Baring's students always have a faculty member who is outside the astrophysics sector, to provide perspectives that can enrich the mentoring. The meetings are normally held in the Fall before Thanksgiving, and generate a formal report that is kept on file. **You are required to set up the meeting(s) in a timely fashion before the deadline**.

RICE HONOR CODE

Throughout your graduate studies with Prof. Baring, you will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. This primarily applies to dedicated classes. Yet in spirit it is also relevant to research, which carries the PHYS 800 class designation. In the research context, it does not prohibit or preclude consultation with or collaboration with other students, postdoctoral fellows or faculty; these are encouraged as needed, for professional preparation purposes. What Prof. Baring mandates is that **the student does not plagiarize prior work in any way** in any of your written or oral communications about research results. Be clear about what is your original contribution, and attribute to identifiable sources (papers, conference presentations, etc.) what others have done previously in a fair and accurate manner. This honesty is an essential part of academic research protocols, motivated by the need to maintain an integrity of the research process in the pursuit of truth.

If you are unfamiliar with the details of the Rice Honor Code and how it is administered, you should consult the Honor System Handbook at http://honor.rice.edu/honor-system-handbook/. This handbook outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.